Drivers for transforming the power grid company

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Abstract: Electricity supply is in the midst of major changes. As part of the green shift, customers will be able to produce and sell electricity, charge electric vehicles and control their energy consumption in smarter ways. This translates into major changes for power grid operators in terms of operations, maintenance, business models and mindset in a traditionally conservative industry. In this paper we present the results from the first phase of a larger marcroergonomic approach for transformation of a power grid company, the capability approach. The contextual analysis is based on interviews with company managers (n=10) in which we identify the external drivers for transformation of a power grid company and its preparedness to meet future demands. This enabled the identification of four organisational competences that the organisation needs to develop further for managing the future demands: analytics, collaboration, innovation and influence.

Keywords: Digital energy system, Capability approach, Macroergonomics

1. Introduction

Electric power distribution grid operators (DSOs; Distribution System Operators) are expected to face new requirements related to competency, planning, security of supply and decision-making capabilities due to increased access to renewable energy, increased efficiency, increased flexibility, and a tighter integration with customers (ENERGIX, 2013). The so-called smart grid will intervene in the energy supply throughout the value chain. This relates to a fully digitised future based on new technologies with cloud computing, internet of things and artificial intelligence. Production and consumption patterns are changing from large centralised generation of electric power and pure consumers to distributed generation and more complex consumers. As summed up by Vinghoets et al. (2016) the power grid companies will have a central role in this development "*As a first step, the current roll-out of smart meters and smart metering infrastructure in Europe will open up wide opportunities for connecting the smart homes, smart buildings and industry 4.0 with the energy grids*".

Political goals enabled by new technology and digitalisation are drivers that will dictate the future role and organisation of these power grid companies, which will need to effectively adapt in a fast-changing market. However, there is large uncertainty regarding the overall mechanisms that will be established in the energy system, and subsequently the internal reconfiguration that will be needed of the grid companies for them to meet the new demands (Reiten et al., 2014).

In a three-year project supported by the Norwegian Research Council, the research institute Institute for Energy Technology (IFE) together with distribution power grid operators are performing a pilot study to identify and describe the capabilities (i.e. organisational competences) that grid operators must possess in order to deliver in a future market. The project focuses on

system innovation rather than technology innovation, and addresses the challenges of deciding, integrating and implementing new technologies (ENERGIX, 2013). The key issue is to characterise the needs for the organisations' structure, expertise and work in the future. The project collects data and develops a method to help grid operators exploit new technologies.
In this paper we present our results from a contextual analysis in the first phase of the project. The aim of the contextual analysis was to perform an organisational diagnosis of a pilot grid company through a shared understanding of a) the main external and internal driving forces of transformation, both short term (i.e. within next year) and longer term (i.e. 3 years), b) the preparedness of the organisation to manage the future demands, and c) the organisational competences that should be further developed.

2. Methodology

In the current study, we adapted an approach for identifying and defining organisational competences necessary for digitalisation in the oil industry, the Capability Approach (Reegård et al., 2014; Reegård et al., 2015). This approach builds on the theoretical basis of resource-based view and dynamic capabilities (Ambrosini et al., 2009; Grant, 2006; Helfat et al., 2007; Henderson et al., 2012; Teece & Pisano, 1994) from the strategic management domain, and is operationalised within applied human factors and a contribution to work system design and the field of macroergonomics (Hendrick and Kleiner, 2002; Kleiner, 2006).
The first step of the approach is to perform a contextual analysis with the purpose of identifying the most influencing contextual aspects for the organisation's delivery. We used a qualitative approach in which we performed semi-structured interviews with 10 managers representing all three production areas in the pilot grid company (three section managers and their seven department managers). To understand the timeline of when different changes are anticipated to occur, we asked the managers to map the changes that they believe will impact on the organisation and their work in a timeline stretching from the current year and to 2021 or beyond. We then asked how they perceive these changes to impact their work, and their perceptions of the section/department's and wider organisation's preparedness to manage the changes. To support the conversation, we brought with us an example timeline with high-level main categories of changes such as regulatory changes (e.g. DSO-role or tariffs), digitalisation (e.g. smart meters), and consumers (e.g. electricity demanding products or consumer knowledge, attitudes and demands). However, the interviewees were mostly self-driven in identifying and discussing the various changes that they experience and anticipate. A research team of three people participated in each interview, one facilitated the interview while the two others took notes.
The data material was analysed through a thematic analysis centred around driving forces of transformation, their expected impact on the organisation, and the organisation's readiness to meet the new demands. A central goal of the analysis was to first separate between main changes that will impact the whole organisation and changes that are rather a concern for parts of the organisation. This allowed us to focus in on the transformational needs that are common across the different production areas in the organisation, and subsequently identify the organisational competences that will benefit the whole organisation. In addition, we performed a document analysis of the organisation's strategic plan to see if there were any additional drivers that we had not identified through the interviews, as well as to identify any relevant measures that the organisation had already implemented or was planning on implementing.
To verify the results of the contextual analysis, the analysis was first summarised in written form and distributed to the organisation for their feedback and input. We then discussed the analysis results with the pilot company and three reference grid companies in a workshop with the purpose

of verifying the main driving forces of transformation. No additional drivers were identified, apart from company-specific drivers for some of the reference companies.

3. Results

The results of the contextual analysis are a description of the future demands of the organisation and an identification of competences that must be prioritised to empower the company to meet those future demands and, subsequently, what that means in term of transforming their current ways of working. The purpose of the contextual analysis was to identify drivers and organisational needs that allows for establishment of theory-based measures and solutions, which constitute the next steps within our chosen approach. In this section, we first provide an overview of the identified drivers of transformation. We then present the analysis of the organisation's preparedness to manage these changes and organisational competence needs.

3.1 Drivers of transformation

The contextual analysis identified four main categories of changes; digitalisation, power grid demands, regulations, and consumer expectations. Figure 1 provides an overview of the timeline of when the different changes are expected to occur.

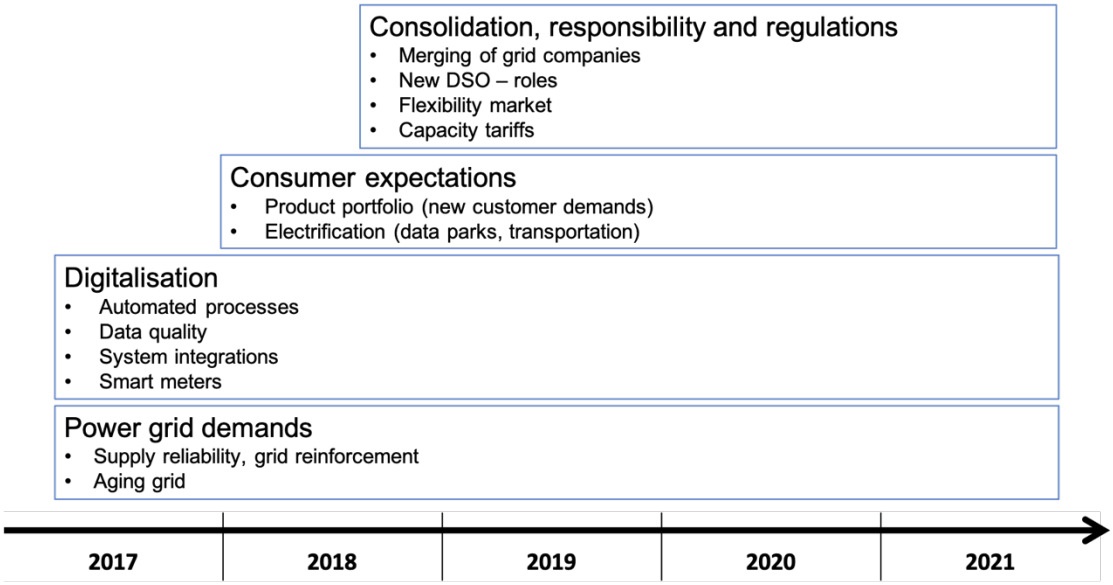

Figure 1: Timeline of when the main drivers of transformation are expected to occur, from the perspective of managers in a grid company

Each of the four types of drivers entail several changes. The analysis made it clear that these drivers are all highly interrelated. The basic challenges are connected to the power grid demands and the very foundation for changes in both regulations and customer expectations is digitalisation.

A Norwegian political goal is that none of the new vehicles sold within the end of 2025 are fossil fuelled. Another significant source for increased power consumption is the decision to ban all use of heating oil from fossil sources within 2020 (Heen Skotland et al., 2016). With the strong incentives for transport electrification, consumers are already ahead of the plan for transition to electrical vehicles. An old and partially under-dimensioned power grid will provide the grid operators with two alternatives: Either they must reinforce the network or consumers have to reduce their peak power consumption in high demand periods.

A key enabler to reduce the need for large reinvestments in the grid is the full coverage with smart meters from 2019 which gives the grid companies a unique access to data and the opportunity to utilise data for automation of work processes, and to better understand the consumption demands of the grid. At the same time, it also requires a great deal of the companies when it comes to quality assurance of data and system integration. The smart meter is further seen as part of a solution package in which consumers are encouraged to change their consumption with the effect of "shaving" the peak power consumption periods. Consequently, the regulator is currently assessing different alternatives for tariff schemes to support such consumer behaviour change. The grid operator will need to communicate to the changes in the tariff scheme to their customers in a way that customers understand so that they can change their consumption behaviour accordingly.

The smart meters provide both the grid operator and the customer with increased information regarding each household's consumption and supply of power. Consumers have increased expectations to systems and ever-increasing digitisation provide new opportunities for customer communication, with increased self-service capabilities and faster information related to voltage quality, interruptions, ground faults, consumption, and connectivity. In addition, the growing customer generation has increased demands for digital services and response times compared to previous generations.

Another political goal for the power grid industry is consolidation. Marching orders from Ministry of Petroleum and Energy (Reiten et al., 2014) is a reduction from the current 130 different power grid companies to larger units and for the industry to take advantage of digitalisation. An important regulatory approach is to give some of the grid operators additional coordination responsibility in the grid (coordinating DSOs).

For companies in the power grid industry to survive the next decade, it seems insufficient to have the management capability "to effectively coordinate and redeploy internal and external competences" (Teece and Pisano 1994, p. 537). Rather, it is essential for them to be able to establish competences that enable them to follow ever-faster technology shifts and regulatory changes, while maintaining high uptime in supply of power. Currently, the power grid companies perceive that the rate of change in technology is faster than the rate of change internally. Both regulators, market actors and grid operators need practical experience with ICT, data analysis, big data volumes, neutrality, digitalisation, new roles in the energy system as well as changes to the DSO role in order to identify solutions for a sustainable energy system. Similarly, the individual grid operator will have to go through a trial period to define its internal reconfiguration. At the same time, the grid operator will need to capture and internally adjust to the progress and key decisions made externally, as well as convey their own experiences in order to influence the future regulatory conditions.

3.2 Organisational preparedness and competence needs

In terms of organisational preparedness to manage these changes, the managers of the pilot grid company made clear that they anticipated large challenges ahead.

First, the organisation had established a large project addressing the new data that will be available to them through the smart meters. This project had already run for a couple of years. However, the managers expressed concern that the project was too detached from the organisation and the people that will make use of the data in daily operations. The managers further explained that the understanding of what the project had developed, and what still needed to be done to use the data in decision-making was somewhat unclear. An influencing factor was that the project was mainly

run by external consultants, and the managers were uncertain if the organisation itself had enough competence to continue the work and implement the technical solutions.
Second, the managers experienced that many processes increased in complexity, needing different disciplines to contribute in various parts of the processes. Although several managers commented that they had made improvements, the interdisciplinary collaboration was still seen as a challenge given that the grid company has traditionally worked within each discipline. They further underscored that their need for effective execution of processes is not just internally oriented, but also relates to external partners (e.g. vendors) because the organisation has a highly market-oriented business model in which a high number of tasks are executed by external partners. Consequently, the various parts of the organisation all have large interfaces to vendors that they rely on and several managers commented that this interface can also be improved both in terms of procurement and follow-up of work.
Third, the organisation had a history of large, successful innovations which was important for improving their work and for positioning themselves relative to other grid companies. However, the fast-pacing changes in external drivers was understood as requiring equally fast-pacing changes internally in the organisation, for which the managers expressed they were uncertain if they had the capacity and means to do. Rather, they mentioned success stories of innovation related to a handful of individuals. Furthermore, the organisation was about to implement "continuous improvements" in an effort to spark a change culture in an organisation that has not experienced needing to change how they conduct their work.
Lastly, the managers underscored that being a grid company means that they are heavily influenced by framework conditions given by the regulator. In addition, they have many stakeholders such as municipalities that are part-owners, landowners, industry customers and private customers that they need to address and whose actions and demands impact on the organisation. The managers expressed that creating the understanding of the grid company perspective and aligning the views of these various stakeholders was challenging and something that they did not have a clear strategy for. Additionally, the anticipated changes and change rate mentioned above means that the organisation need to create understanding of new ways of working internally as well. Such change management was also seen as challenging by the managers.
To summarise, to meet the future demands, the organisation needs to establish the capability to manage and utilise data as a basis for operational decisions (operation, maintenance and investment), especially considering the expected increased complexity of operating the grid in which prediction will be central for making sound decisions for optimisation of the grid. New and changing regulatory requirements, increased grid operation complexity, and increased access to relevant data imply a need for greater reliance on interdisciplinary decision-making processes. This means that the company should have the ability to collaborate across existing boundaries both internally and externally. The fast-paced changes that impact on the energy sector make it necessary for the company to build and further develop innovation capabilities for maturing its own technology and knowledge stack. Equally important, this will also contribute to strengthen the company's ability to influence its own employees, the industry and regulators to drive development in a, to the company, favourable direction. Consequently, the organisational competences that the context analysis identified as prioritised focus areas are:

- *Analytics* - Extract, quality assure and consolidate data for utilisation in decision making;
- *Collaboration* - Involve relevant expertise and authority at the right time in decision making regardless of organisational and geographical location;

- *Innovation* - Identify and develop business opportunities and leverage new development (s) in the organisation; and
- *Influence* - Change, develop, and customise the framework conditions to the identified business opportunities.

When addressing and maturing these competences in the organisation, the company needs a framework for selection, development and implementation of appropriate measures. Henderson et al. (2013) represents the information ecology for competence intensive organisations operating in highly developed networked markets as a capability stack model. In this study, we adapted the model to represent the identified organisational competences in the company stack to support the further development of these competences. The strength of such a model is that it provides a logical division of technology levels, analysis levels, people skills levels, and a language that supports communication in and with the organisation. The model highlights the important point that to ensure business delivery, the needs of each operational task or service must be addressed through alignment of all layers. The further detailing and development of the organisational competences constitute next steps in our chosen approach and is not within the scope of this paper. Figure 2 shows how the identified competences are to deliver into the grid company's competence stack.

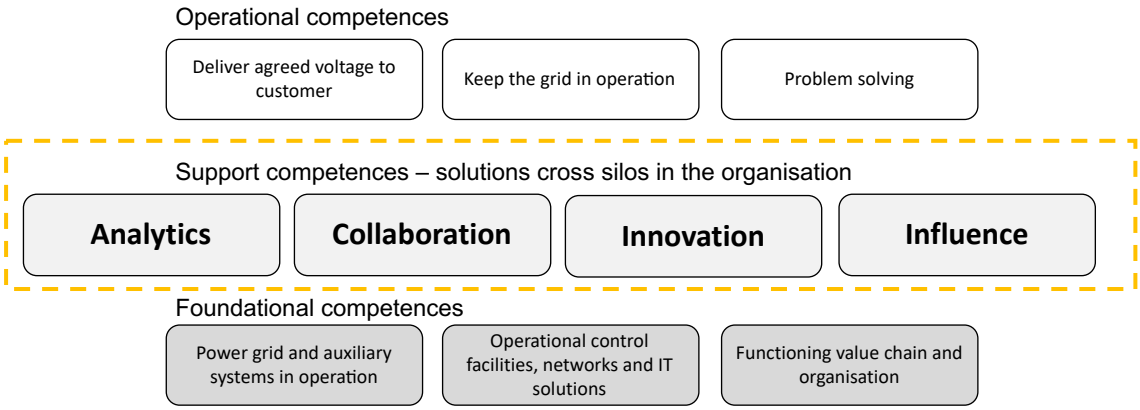

Figure 2: Stack model representing a support layer consisting of the identified organisational competences.

4. Conclusions

In this paper, we report on a contextual analysis for a power grid company in which we performed an organisational diagnosis consisting of identification of main drivers for transformation, how these are expected to impact on the company, and the organisation's readiness to meet the future demands. The results from interviews with 10 managers in the grid company show that major drivers of transformation are related to power grid demands, digitalisation, regulations and customer expectations. Specifically, the basic challenges are connected to the power grid demands while digitalisation is seen as a key enabler for solving these challenges and constitute the very foundation for changes in both regulations and customer expectations. However, the managers did not perceive the organisation to be ready to face these changes immediately. Rather, they identified several internal challenges that need to be further addressed. The contextual analysis resulted in the identification of four organisational competences that the organisation needs to develop further for managing the future demands: analytics, collaboration, innovation and influence.

The current study is not without limitations. The results in terms of main drivers may not be generalisable to other grid companies, although we did take measures to verify that the same drivers of transformation apply to others. One of the apparent weaknesses is that the screening of what was deemed company-specific drivers was performed prior to discussion with the reference grid companies. Furthermore, we did not do the same thorough interview rounds with these other grid companies, but rather discussed the main drivers with them in a workshop. Consequently, we cannot rule out that other grid companies share similar drivers as those we deemed to be company specific, that entirely different drivers exist, or that the drivers identified may be more nuanced.

Despite the limitations concerning generalisability, the main purpose of this study was to identify and describe, at a high level, the organisational competences that grid operators must possess to deliver in a future market by use of a pilot company. In the next phase of the 3-year project, these competences will be described in detail as well as how they can be developed. As such the contextual analysis has been a key activity enabling early understanding of specific organisational needs in a transformation process. This, in turn, contribute to paving the way for acceptance of addressing human, technology and organisational needs through further activities and interventions tailored to the organisation.

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